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Jeong

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(54) **LIGHT-EMITTING DEVICE, LIGHT-EMITTING DEVICE PACKAGE, AND LIGHT UNIT**

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USPC 257/98, 99, 100
See application file for complete search history.

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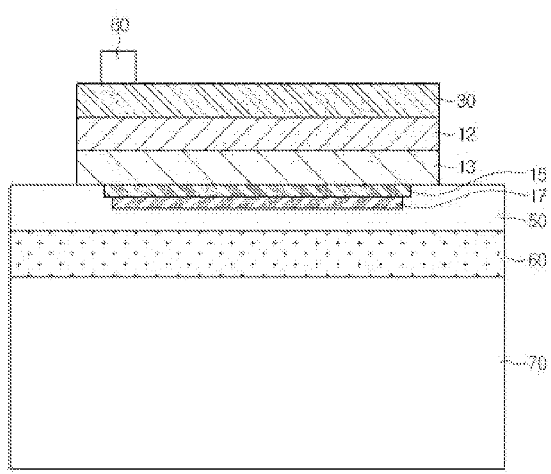
(57) **ABSTRACT**

A light-emitting device, according to one embodiment, comprises: a transparent conductive oxide film; an active layer which comes into contact with a lower surface of the transparent conductive oxide layer; a first conductive semiconductor layer which comes into contact with a lower surface of the active layer; a reflective electrode which is electrically connected to the first conductive semiconductor layer; and a first electrode electrically connected to the transparent conductive oxide layer.

19 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

H01L 33/40	(2010.01)
H01L 33/48	(2010.01)
H01L 33/58	(2010.01)
H01L 33/62	(2010.01)
F21K 99/00	(2016.01)
F21V 3/02	(2006.01)
F21V 23/00	(2015.01)
F21Y 101/02	(2006.01)
F21V 29/77	(2015.01)

(52) **U.S. Cl.**

CPC ... *F21Y 2101/02* (2013.01); *H01L 2224/48091* (2013.01)

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FIG. 1

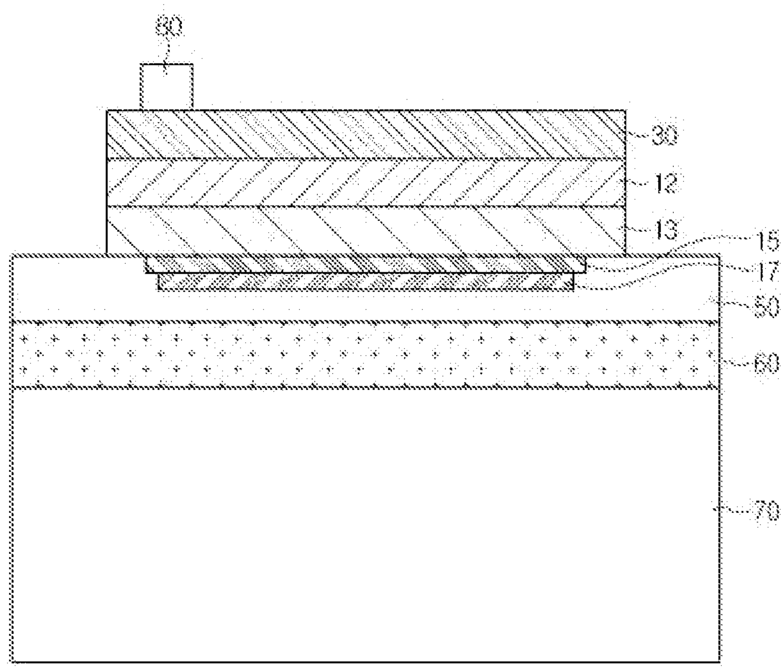

FIG. 2

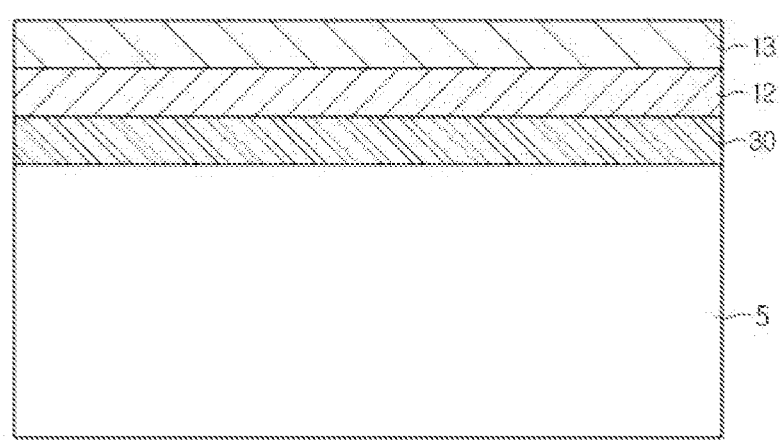

FIG. 3

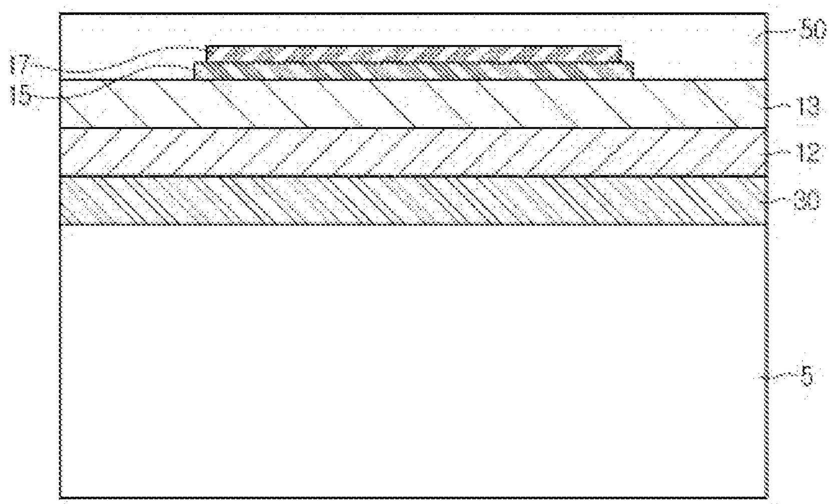

FIG. 4

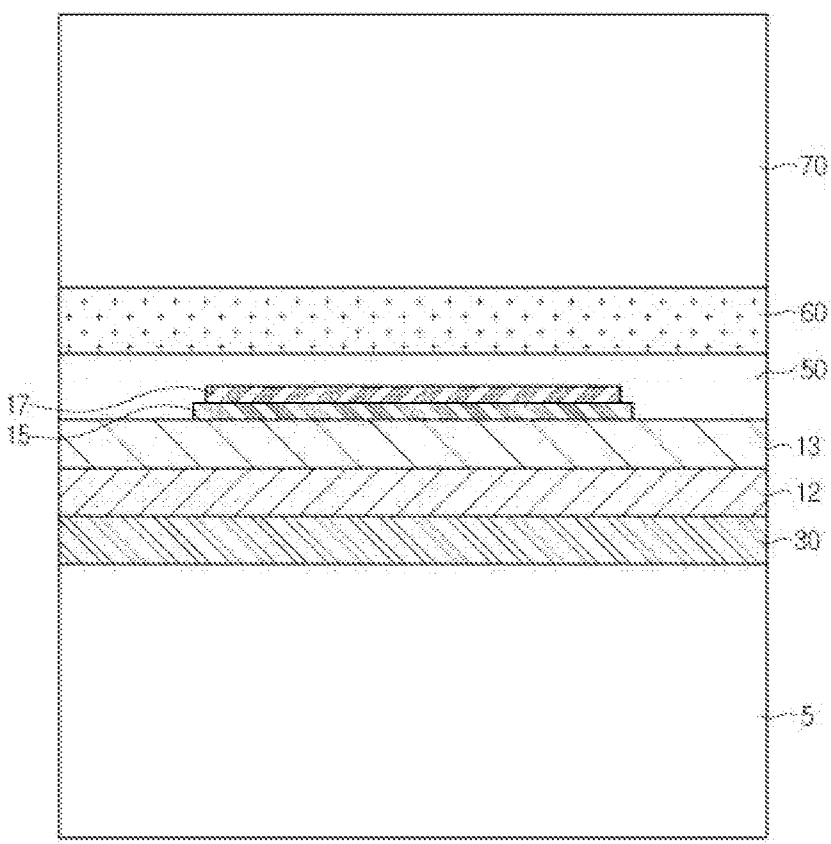

FIG. 5

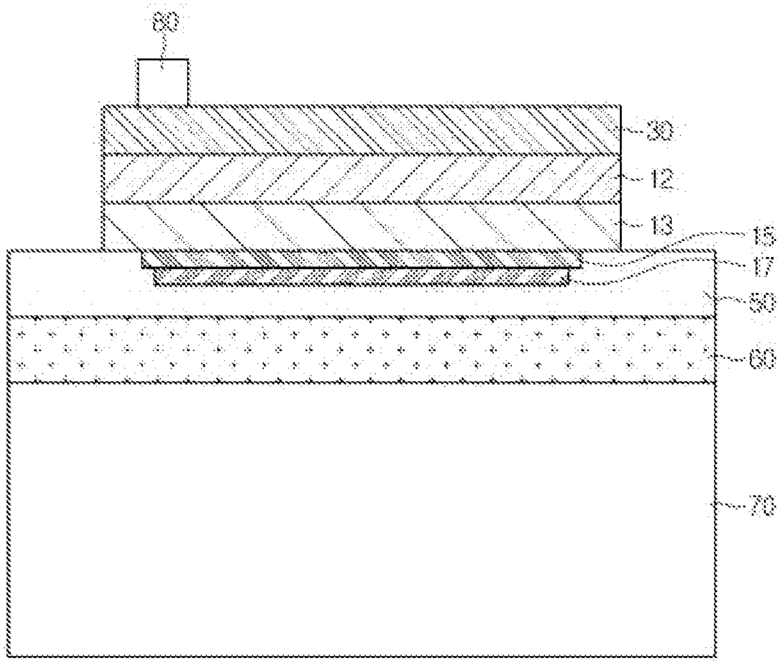

FIG. 6

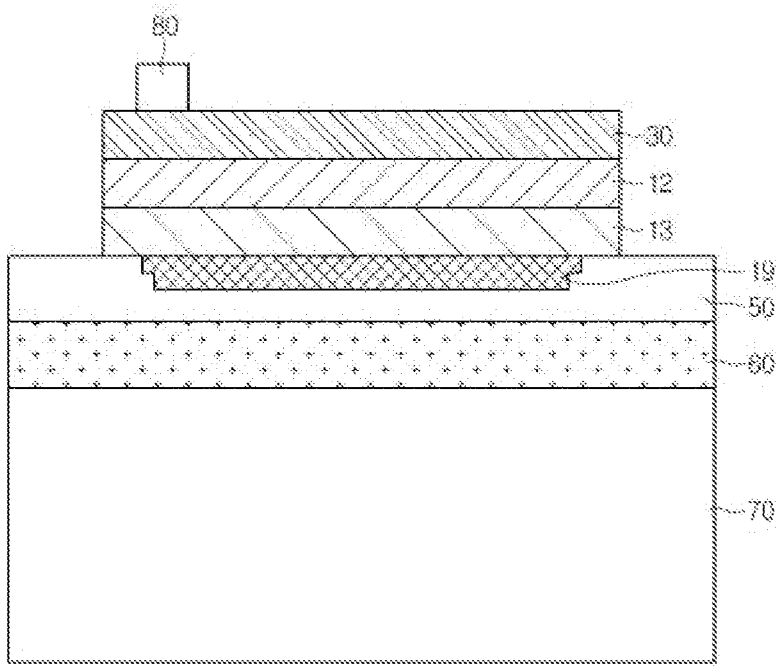

FIG. 7

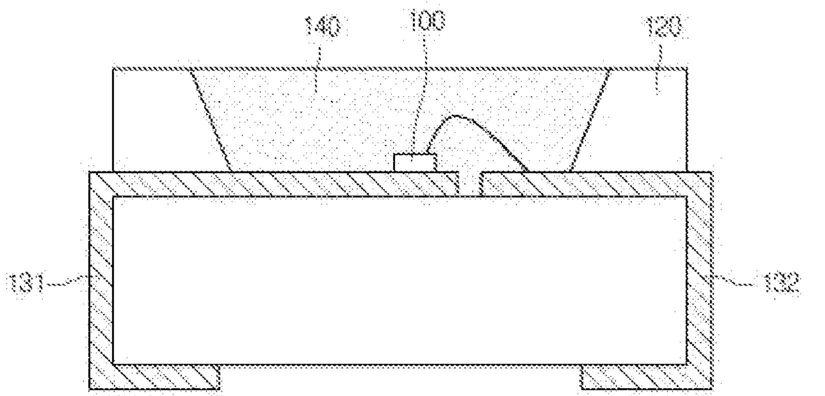
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FIG. 8

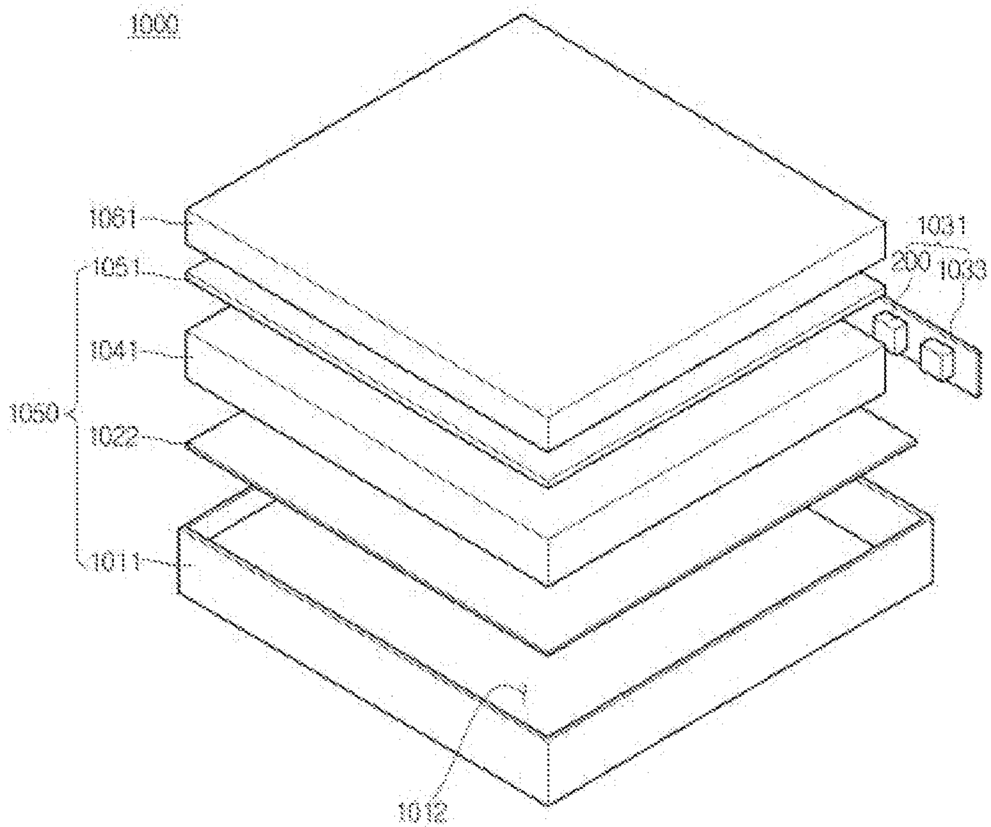
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FIG. 9

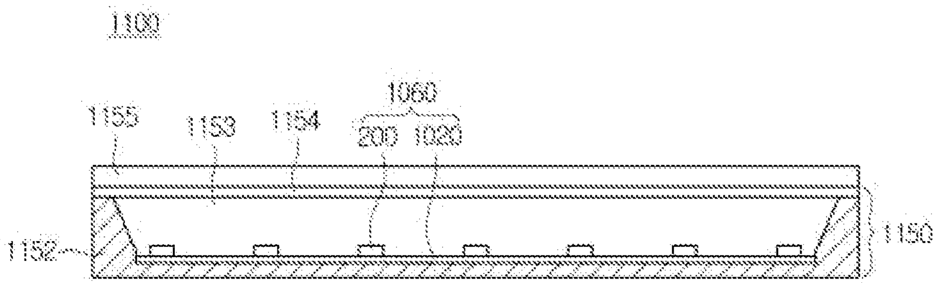

FIG. 10

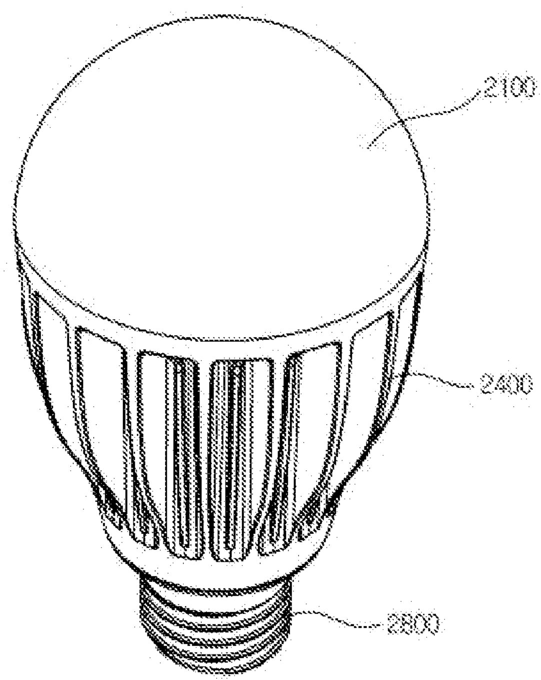

FIG. 11

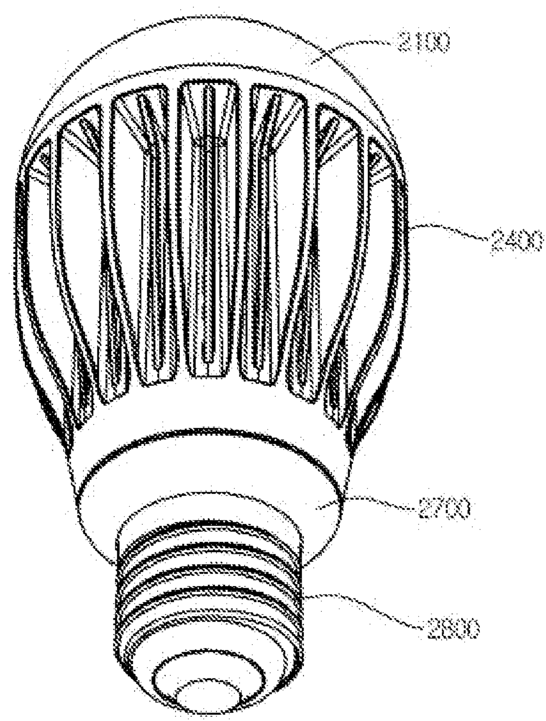

FIG. 12

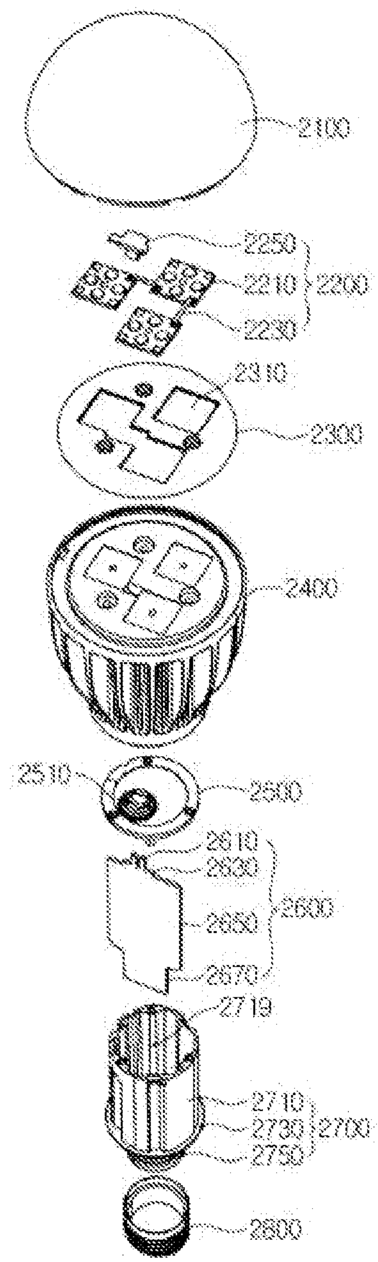
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FIG. 13

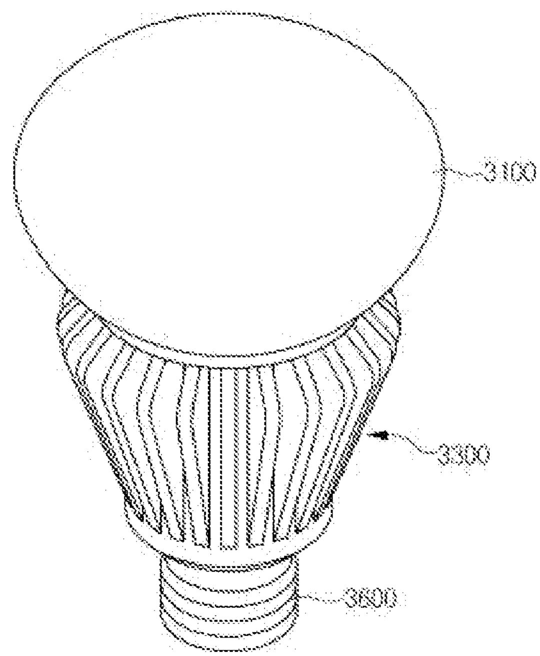
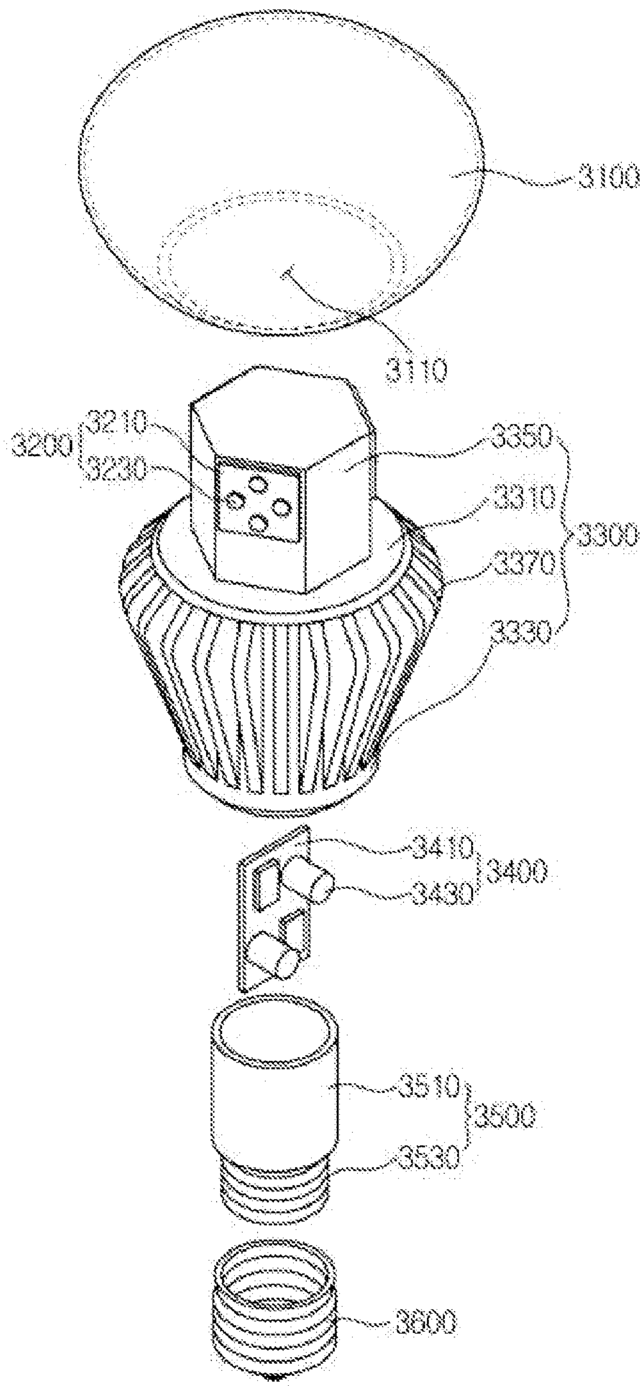


FIG. 14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LIGHT-EMITTING DEVICE, LIGHT-EMITTING DEVICE PACKAGE, AND LIGHT UNIT

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application is a U.S. National Stage Application under 35 U.S.C. §371 of PCT Application No. PCT/KR2013/004502, filed May 22, 2013, which claims priority to Korean Patent Application No. 10-2012-0061374, filed Jun. 8, 2012, whose entire disclosures are hereby incorporated by reference.

TECHNICAL FIELD

The embodiment relates to a light-emitting device, a light-emitting device package, and a light unit.

BACKGROUND ART

A light-emitting diode (LED) has been extensively used as one of light-emitting devices. The LED converts electrical signals into the form of light such as infra-red light, ultra-violet light, and visible light by using the characteristic of a compound semiconductor.

As the light efficiency of the light-emitting device is increased, the LED has been used in various fields such as display apparatuses and lighting appliances.

DISCLOSURE

Technical Problem

The embodiment provides a light-emitting device, a light-emitting device package, and a light unit, capable of improving light extraction efficiency.

Technical Solution

A light-emitting device according to the embodiment includes: a transparent conductive oxide layer; an active layer making contact with a bottom surface of the transparent conductive oxide layer; a first conductive semiconductor layer making contact with a bottom surface of the active layer; a reflective electrode electrically connected to the first conductive semiconductor layer; and a first electrode electrically connected to the transparent conductive oxide layer.

A light-emitting device package according to the embodiment includes: a body; a light-emitting device on the body; and first and second lead electrodes electrically connected to the light-emitting device, wherein the light-emitting device includes a transparent conductive oxide layer; an active layer making contact with a bottom surface of the transparent conductive oxide layer; a first conductive semiconductor layer making contact with a bottom surface of the active layer; a reflective electrode electrically connected to the first conductive semiconductor layer; and a first electrode electrically connected to the transparent conductive oxide layer.

A light unit according to the embodiment includes: a substrate; a light-emitting device on the substrate; and an optical member serving as an optical path for light emitted from the light-emitting device, wherein the light-emitting device includes a transparent conductive oxide layer; an active layer making contact with a bottom surface of the transparent conductive oxide layer; a first conductive semiconductor layer making contact with a bottom surface of the active layer; a

reflective electrode electrically connected to the first conductive semiconductor layer; and a first electrode electrically connected to the transparent conductive oxide layer.

Advantageous Effects

The light-emitting device, the light-emitting device package, and the light unit according to the embodiment can improve the light extraction efficiency.

DESCRIPTION OF DRAWINGS

FIG. **1** is a view showing a light-emitting device according to the embodiment.

FIGS. **2** to **5** are views showing a method of fabricating a light-emitting device according to the embodiment.

FIG. **6** is a view showing a modified example of a light-emitting device according to the embodiment.

FIG. **7** is a view showing a light-emitting device package according to the embodiment.

FIG. **8** is a view showing a display device according to the embodiment.

FIG. **9** is a view showing another example of the display device according to the embodiment.

FIGS. **10** to **12** are views showing a lighting apparatus according to the embodiment.

FIGS. **13** and **14** are views showing another example of a lighting apparatus according to the embodiment.

BEST MODE

Mode for Invention

In the description of the embodiments, it will be understood that, when a layer (or film), a region, a pattern, or a structure is referred to as being on or "under" another substrate, another layer (or film), another region, another pad, or another pattern, it can be "directly" or "indirectly" over the other substrate, layer (or film), region, pad, or pattern, or one or more intervening layers may also be present. Such a position of the layer has been described with reference to the drawings.

The thickness and size of each layer shown in the drawings may be exaggerated, omitted or schematically drawn for the purpose of convenience or clarity. In addition, the size of elements does not utterly reflect an actual size.

Hereinafter, a light-emitting device, a light-emitting device package, a light unit, and a method for fabricating the light-emitting device according to the embodiments will be described in detail with reference to accompanying drawings.

FIG. **1** is a view showing a light-emitting device according to the embodiment.

As shown in FIG. **1**, the light-emitting device according to the embodiment may include an active layer **12**, a first conductive semiconductor layer **13**, a reflective electrode **17**, a transparent conductive oxide layer **30** and a first electrode **80**.

A light-emitting structure used in a light-emitting device according to the related art includes a first conductive semiconductor layer doped with first conductive dopants and a second conductive semiconductor layer doped with second conductive dopants. However, a light-emitting structure used in the light-emitting device according to the embodiment may be constituted by the first conductive semiconductor layer **13**, the active layer **12** and the transparent conductive oxide layer **30**.

The transparent conductive oxide layer **30** may include an ITO (Indium Tin Oxide) or a ZnO. For instance, the transparent conductive oxide layer **30** may include at least one selected from the group consisting of an ITO (Indium Tin Oxide), an IZO (Indium Zinc Oxide), an AZO (Aluminum Zinc Oxide), an AGZO (Aluminum Gallium Zinc Oxide), an IZTO (Indium Zinc Tin Oxide), an IAZO (Indium Aluminum Zinc Oxide), an IGZO (Indium Gallium Zinc Oxide), an IGTO (Indium Gallium Tin Oxide), an ATO (Antimony Tin Oxide), a GZO (Gallium Zinc Oxide), an IZON (IZO Nitride), and ZnO.

The active layer **12** may be disposed under the transparent conductive oxide layer **30**. The active layer **12** may make contact with a bottom surface of the transparent conductive oxide layer **30**. The first conductive semiconductor layer **13** may be disposed under the active layer **12**. The first conductive semiconductor layer **13** may make contact with a bottom surface of the active layer **12**.

The reflective electrode **17** may be electrically connected to the first conductive semiconductor layer **13**. For instance, the reflective electrode **17** may be disposed under the first conductive semiconductor layer **13**. The first electrode **80** may be electrically connected to the transparent conductive oxide layer **30**. For instance, the first electrode **80** may be disposed on the transparent conductive oxide layer **30**. The first electrode **80** may make contact with a top surface of the transparent conductive oxide layer **30**.

According to the embodiment, for instance, the first electrode **80** may serve as an n-type electrode and the reflective electrode **17** may serve as a p-type electrode. In this case, the first conductive semiconductor layer **13** may include a p-type semiconductor layer doped with p-type dopants as first conductive dopants. The transparent conductive oxide layer **30**, for example, may has a thickness in the range of 10 nm to 500 nm. The transparent conductive oxide layer **30** has a superior current spreading characteristic, so the transparent conductive oxide layer **30** can effectively spread current input from the first electrode **80**. The transparent conductive oxide layer **30** may spread electrons input from the first electrode **80** to effectively transfer the electrons to the active layer **12**.

For example, the first conductive semiconductor layer **13** may include a p-type semiconductor layer. The first conductive semiconductor layer **13** may be realized by using a compound semiconductor. For instance, the first conductive semiconductor layer **13** may be realized by using a group II-VI compound semiconductor or a group III-V compound semiconductor.

For example, the first conductive semiconductor layer **13** may be realized by using a semiconductor material having a compositional formula of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). For example, the first conductive semiconductor layer **13** may include one selected from the group consisting of GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AlInN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP doped with n-type dopants such as Mg, Zn, Ca, Sr and Ba.

The active layer **12** emits light having a wavelength corresponding to the energy band gap difference according to materials constituting the active layer **13** through the combination of electrons (or holes) injected through the transparent conductive oxide layer **30** and holes (or electrons) injected through the first conductive semiconductor layer **13**. The active layer **12** may have one of a single quantum well (SQW) structure, a multi-quantum well (MQW) structure, a quantum dot structure, and a quantum wire structure, but the embodiment is not limited thereto.

The active layer **12** may be realized by using a compound semiconductor. The active layer **12** may be realized by using a semiconductor material having a compositional formula of InxAlyGa1-x-yN ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). When the active layer **12** has an MQW structure, the active layer **12** may be formed by stacking a plurality of well layers and a plurality of barrier layers. For example, the active layer **12** may have a cycle of InGaN well layer/GaN barrier layer.

Meanwhile, the first conductive semiconductor layer **13** may include an n-type semiconductor layer doped with n-type dopants as first conductive dopants. For example, the first conductive semiconductor layer **13** may include an n-type semiconductor layer. For example, the first conductive semiconductor layer **13** may be realized by using a compound semiconductor. For example, the first conductive semiconductor layer **13** may be realized by using a group II-VI compound semiconductor or a group II-V compound semiconductor.

For example, the first conductive semiconductor layer **13** may be realized by using a semiconductor material having a compositional formula of InxAlyGa1-x-yN ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). For example, the first conductive semiconductor layer **13** may include one selected from the group consisting of GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AlInN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP doped with n-type dopants such as Si, Ge, Sn, Se and Te.

In addition, impurities may be doped into the first conductive semiconductor layer **13** with uniform or non-uniform doping concentration. In other words, the light-emitting structure according to the embodiment may be variously configured, and the embodiment is not limited thereto.

In addition, a first conductive InGaN/GaN superlattice structure or InGaN/InGaN superlattice structure may be formed between the first conductive semiconductor layer **13** and the active layer **12**. In addition, a first conductive AlGaN layer may be formed between the first conductive semiconductor layer **13** and the active layer **12**.

According to the embodiment, a first barrier layer constituting the active layer **12** may be formed of nitride semiconductor including In or Al. In this case, the first barrier layer may make contact with a bottom surface of the transparent conductive oxide layer **30**. The first barrier layer may make ohmic-contact with the transparent conductive oxide layer **30**.

The reflective electrode **17** may be disposed under the first conductive semiconductor layer **13**. An ohmic contact layer **15** may be further disposed between the first conductive semiconductor layer **13** and the reflective electrode **17**. A metal layer **50** may be disposed under the first conductive semiconductor layer **13** and around the ohmic contact layer **15**. The metal layer **50** may be disposed around a lower portion of the first conductive semiconductor layer **13**. The metal layer **50** may be disposed around the reflective electrode **17**.

The metal layer **50** may make contact with a bottom surface of the first conductive semiconductor layer **13**. A first region of the metal layer **50** may make contact with a bottom surface of the first conductive semiconductor layer **13**. A second region of the metal layer **50** may extend outward from the first region. The second region of the metal layer **50** may extend in the horizontal direction from the first region.

For example, the ohmic contact layer **15** may include a transparent conductive oxide layer. For example, the ohmic contact layer **15** may include at least one selected from the group consisting of an ITO (Indium Tin Oxide), an IZO (Indium Zinc Oxide), an AZO (Aluminum Zinc Oxide), an AGZO (Aluminum Gallium Zinc Oxide), an IZTO (Indium Zinc Tin Oxide), an IAZO (Indium Aluminum Zinc Oxide), an IGZO (Indium Gallium Zinc Oxide), an IGTO (Indium Gallium Tin Oxide), an ATO (Antimony Tin Oxide), a GZO (Gallium Zinc Oxide), an IZON (IZO Nitride), ZnO, IrOx, RuOx, NiO, Pt and Ag.

The reflective electrode **17** may include a material having high reflectance. For example, the reflective electrode **17** may include a metal including at least one of Ag, Ni, Al, Rh, Pd, Ir, Ru, Mg, Zn, Pt, Cu, Au, and Hf, or an alloy thereof. In addition, the reflective electrode **17** may be formed in a multi-layer of the metal or the alloy thereof and a transmissive conductive material such as an ITO (Indium-Tin-Oxide), an IZO (Indium-Zinc-Oxide), an IZTO (Indium-Zinc-Tin-Oxide), an IAZO (Indium-Aluminum-Zinc-Oxide), an IGZO (Indium-Gallium-Zinc-Oxide), an IGTO (Indium-Gallium-Tin-Oxide), an AZO (Aluminum-Zinc-Oxide), or an ATO (Antimony-Tin-Oxide). For example, according to the embodiment, the reflective electrode **17** may include at least one of Ag, Al, an Ag—Pd—Cu alloy, and an Ag—Cu alloy.

The ohmic contact layer **15** may make ohmic-contact with the first conductive semiconductor layer **13**. In addition, the reflective electrode **17** may reflect light incident thereto from the light-emitting structure to increase the quantity of light extracted to an outside.

The metal layer **50** may include at least one of Cu, Ni, Ti, Ti—W, Cr, W, Pt, V, Fe, and Mo. The metal layer **50** may serve as a diffusion barrier layer. A bonding layer **60** and a support member **70** may be disposed under the metal layer **50**.

The metal layer **50** may prevent a material included in the bonding layer **60** from being diffused to the reflective electrode **17** in the process of providing the bonding layer **60**. The metal layer **50** may prevent a material, such as Sn, included in the bonding layer **60** from exerting an influence upon the reflective electrode **17**.

The bonding layer **60** may include barrier metal or bonding metal. For example, the bonding layer **60** may include at least one of Ti, Au, Sn, Ni, Cr, Ga, In, Bi, Cu, Ag, Nb, Pd and Ta. The support member **70** may support the light-emitting structure **10** according to the embodiment while performing a heat radiation function. The bonding layer **60** may be realized in the form of a seed layer.

The support member **70** may include at least one of semiconductor substrates (e.g., Si, Ge, GaN, GaAs, ZnO, SiC, and SiGe substrates) implanted with Ti, Cr, Ni, Al, Pt, Au, W, Cu, Mo, Cu—W, or impurities. For example, the support member **70** may be formed of insulating material.

The light-emitting device according to the embodiment may include the first electrode **80** electrically connected to the transparent conductive oxide layer **30**. For example, the first electrode **80** may be disposed on the transparent conductive oxide layer **30**. The first electrode **80** may make contact with the transparent conductive oxide layer **30**.

According to the embodiment, power may be applied to the light-emitting structure through the reflective electrode **17** and the first electrode **80**. According to the embodiment, the first electrode **80** may be realized in the form of a multiple layer. The first electrode **80** may include an ohmic layer, an intermediate layer, and an upper layer. The ohmic layer may include a material selected from the group consisting of Cr, V, W, Ti, and Zn to realize ohmic contact. The intermediate layer may be realized by using a material selected from the group consisting of Ni, Cu, and Al. For example, the upper layer may include Au. The first electrode **80** may include at least one selected from the group consisting of Cr, V, W, Ti, Zn, Ni, Cu, Al, and Au.

A light-emitting structure used in a light-emitting device according to the related art includes a first conductive semiconductor layer doped with first conductive dopants and a second conductive semiconductor layer doped with second conductive dopants. However, a light-emitting structure used in the light-emitting device according to the embodiment may be constituted by the first conductive semiconductor layer **13**, the active layer **12** and the transparent conductive oxide layer **30**. That is, the embodiment employs the transparent conductive oxide layer **30** instead of a second conductive semiconductor layer of the light-emitting device according to the related art.

Therefore, photons emitted from the active layer **12** can be extracted to the outside through the transparent conductive oxide layer **30**. As a result, photons emitted from the active layer **12** may not be absorbed in the semiconductor layer, so that the light efficiency can be improved.

Hereinafter, a method of fabricating the light-emitting device according to the embodiment will be described with reference to FIGS. **2** to **5**.

According to the method of fabricating the light-emitting device of the embodiment, as shown in FIG. **2**, the transparent conductive oxide layer **30**, the active layer **12**, and the first conductive semiconductor layer **13** may be formed on a substrate **5**. The transparent conductive oxide layer **30**, the active layer **12**, and the first conductive semiconductor layer **13** may be defined as the light-emitting structure

For example, the substrate **5** may include at least one of a sapphire substrate (Al_2O_3), SiC, GaAs, GaN, ZnO, Si, GaP, InP, and Ge, but the embodiment is not limited thereto. A buffer layer may be interposed between the transparent conductive oxide layer **30** and the substrate **5**.

For example, the transparent conductive oxide layer **30** may be formed through a sputtering scheme or an MBE scheme. The transparent conductive oxide layer **30** may include an ITO (Indium Tin Oxide) or a ZnO. For instance, the transparent conductive oxide layer **30** may include at least one selected from the group consisting of an ITO (Indium Tin Oxide), an IZO (Indium Zinc Oxide), an AZO (Aluminum Zinc Oxide), an AGZO (Aluminum Gallium Zinc Oxide), an IZTO (Indium Zinc Tin Oxide), an IAZO (Indium Aluminum Zinc Oxide), an IGZO (Indium Gallium Zinc Oxide), an IGTO (Indium Gallium Tin Oxide), an ATO (Antimony Tin Oxide), a GZO (Gallium Zinc Oxide), an IZON (IZO Nitride), and ZnO.

The active layer **12** may be formed on the transparent conductive oxide layer **30**. The active layer **12** may be realized by using a compound semiconductor. For example, the active layer **12** may be realized by using a group II-VI or III-V compound semiconductor. In addition, for example, the active layer **12** may be realized by using a semiconductor material having a compositional formula of InxAlyGa1-x-yN ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). When the active layer **12** has an MQW structure, the active layer **12** may be formed by stacking a plurality of well layers and a plurality of barrier layers. For example, the active layer **12** may have a cycle of InGaN well layer/GaN barrier layer.

The first conductive semiconductor layer **13** may be formed on the active layer **12**. The first conductive semiconductor layer **13**, for example, may include a p-type semiconductor layer. The first conductive semiconductor layer **13** may include a compound semiconductor. For example, the first conductive semiconductor layer **13** may be realized by using a group II-VI or III-V compound semiconductor.

For example, the first conductive semiconductor layer **13** may be realized by using a semiconductor material having a compositional formula of InxAlyGa1-x-yN ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). For example, the second conductive semiconductor layer **13** may include one selected from the group consisting of GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AlInN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP doped with p-type dopants such as Mg, Zn, Ca, Sr, and Ba.

Meanwhile, the first conductive semiconductor layer **13** may include an n-type semiconductor layer doped with n-type dopants as first conductive dopants. For example, the first conductive semiconductor layer **13** may include an n-type semiconductor layer. For example, the first conductive semiconductor layer **13** may be realized by using a compound semiconductor. For example, the first conductive semiconductor layer **13** may be realized by using a group II-VI compound semiconductor or a group II-V compound semiconductor.

For example, the first conductive semiconductor layer **13** may be realized by using a semiconductor material having a compositional formula of $In_xAl_yGa_{1-x-y}N$ ($0 \le x \le 1$, $0 \le y \le 1$, $0 \le x+y \le 1$). For example, the first conductive semiconductor layer **13** may include one selected from the group consisting of GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AlInN, AlGaAs, GaP, GaAs, GaAsP, and AlGaInP doped with n-type dopants such as Mg, Zn, Ca, Sr and Ba.

In addition, impurities may be doped into the first conductive semiconductor layer **13** with uniform or non-uniform doping concentration. In other words, the light-emitting structure according to the embodiment may be variously configured, and the embodiment is not limited thereto.

In addition, a first conductive InGaN/GaN superlattice structure or InGaN/InGaN superlattice structure may be formed between the first conductive semiconductor layer **13** and the active layer **12**. In addition, a first conductive AlGaN layer may be formed between the first conductive semiconductor layer **13** and the active layer **12**.

Then, as shown in FIG. **3**, the ohmic contact layer **15** and the reflective electrode **17** may be formed on the first conductive semiconductor layer **13**.

For example, the ohmic contact layer **15** may include a transparent conductive oxide layer. For example, the ohmic contact layer **15** may include at least one selected from the group consisting of an ITO (Indium Tin Oxide), an IZO (Indium Zinc Oxide), an AZO (Aluminum Zinc Oxide), an AGZO (Aluminum Gallium Zinc Oxide), an IZTO (Indium Zinc Tin Oxide), an IAZO (Indium Aluminum Zinc Oxide), an IGZO (Indium Gallium Zinc Oxide), an IGTO (Indium Gallium Tin Oxide), an ATO (Antimony Tin Oxide), a GZO (Gallium Zinc Oxide), an IZON (IZO Nitride), ZnO, IrOx, RuOx, NiO, Pt and Ag.

The reflective electrode **17** may include a material having high reflectance. For example, the reflective electrode **17** may include a metal including at least one of Ag, Ni, Al, Rh, Pd, Ir, Ru, Mg, Zn, Pt, Cu, Au, and Hf, or an alloy thereof. In addition, the reflective electrode **17** may be formed in a multilayer of the metal or the alloy thereof and a transmissive conductive material such as an ITO (Indium-Tin-Oxide), an IZO (Indium-Zinc-Oxide), an IZTO (Indium-Zinc-Tin-Oxide), an IAZO (Indium-Aluminum-Zinc-Oxide), an IGZO (Indium-Gallium-Zinc-Oxide), an IGTO (Indium-Gallium-Tin-Oxide), an AZO (Aluminum-Zinc-Oxide), or an ATO (Antimony-Tin-Oxide). For example, according to the embodiment, the reflective electrode **17** may include at least one of Ag, Al, an Ag—Pd—Cu alloy, and an Ag—Cu alloy.

In addition, as shown in FIG. **4**, the metal layer **50** may be formed on the reflective electrode **17**. The metal layer **50** may be disposed around the ohmic contact layer **15** and on the reflective electrode **17**. The metal layer **50** may include at least one of Cu, Ni, Ti, Ti—W, Cr, W, Pt, V, Fe, and Mo. The metal layer **50** may serve as a diffusion barrier layer. The metal layer may serve as a diffusion barrier layer.

Meanwhile, the above processes for forming layers are illustrative purpose only and the process sequence may be variously changed.

Then, as shown in FIG. **4**, the bonding layer **60** and the support member **70** may be provided on the metal layer **50**. The metal layer **50** may prevent a material included in the bonding layer **60** from being diffused to the reflective electrode **17** in the process of providing the bonding layer **60**. The metal layer **50** may prevent a material, such as Sn, included in the bonding layer **60** from exerting an influence upon the reflective electrode **17**.

The bonding layer **60** may include barrier metal or bonding metal. For example, the bonding layer **60** may include at least one of Ti, Au, Sn, Ni, Cr, Ga, In, Bi, Cu, Ag, Nb, Pd and Ta. The support member **70** may support the light-emitting structure **10** according to the embodiment while performing a heat radiation function. The bonding layer **60** may be realized in the form of a seed layer.

The support member **70** may include at least one of semiconductor substrates (e.g., Si, Ge, GaN, GaAs, ZnO, SiC, and SiGe substrates) implanted with Ti, Cr, Ni, Al, Pt, Au, W, Cu, Mo, Cu—W, or impurities.

Next, the substrate **5** is removed from the transparent conductive oxide layer **30**. According to one example, the substrate **5** may be removed through a laser lift off (LLO) process. The LLO process is a process to delaminate the substrate **5** from the transparent conductive oxide layer **30** by irradiating a laser to the bottom surface of the substrate **5**.

Then, as shown in FIG. **5**, the lateral side of the light-emitting structure **10** is etched through an isolation etching process to expose a portion of the metal layer **50**. The isolation etching process may be performed through a dry etching process such as an inductively coupled plasma (ICP) process, but the embodiment is not limited thereto.

A first region of the metal layer **50** may be disposed under the light-emitting structure **10**. A second region of the metal layer **50** may extend outward from the first region. The second region of the metal layer **50** may horizontally extend from the first region. The second region of the metal layer **50** may be exposed to a lower outer peripheral portion of the light-emitting structure.

In addition, as shown in FIG. **5**, the first electrode **80** may be electrically connected to the transparent conductive oxide layer **30**. For instance, the first electrode **80** may be disposed on the transparent conductive oxide layer **30**. The first electrode **80** may make contact with a top surface of the transparent conductive oxide layer **30**.

According to the embodiment, the first electrode **80** may be realized in the form of a multiple layer. The first electrode **80** may include an ohmic layer, an intermediate layer, and an upper layer. The ohmic layer may include a material selected from the group consisting of Cr, V, W, Ti, and Zn to realize ohmic contact. The intermediate layer may be realized by using a material selected from the group consisting of Ni, Cu, and Al. For example, the upper layer may include Au. The first electrode **80** may include at least one selected from the group consisting of Cr, V, W, Ti, Zn, Ni, Cu, Al, and Au.

According to the embodiment, for instance, the first electrode **80** may serve as an n-type electrode and the reflective electrode **17** may serve as a p-type electrode. In this case, the first conductive semiconductor layer **13** may include a p-type semiconductor layer doped with p-type dopants as first conductive dopants. The transparent conductive oxide layer **30**, for example, may has a thickness in the range of 10 nm to 500 nm. The transparent conductive oxide layer **30** has a superior current spreading characteristic, so the transparent conductive oxide layer **30** can effectively spread current input from the first electrode **80**. The transparent conductive oxide layer **30** may spread electrons input from the first electrode **80** to effectively transfer the electrons to the active layer **12**.

According to the embodiment, power may be applied to the light-emitting structure through the reflective electrode **17** and the first electrode **80**.

A light-emitting structure used in a light-emitting device according to the related art includes a first conductive semiconductor layer doped with first conductive dopants and a second conductive semiconductor layer doped with second conductive dopants. However, a light-emitting structure used in the light-emitting device according to the embodiment may be constituted by the first conductive semiconductor layer **13**, the active layer **12** and the transparent conductive oxide layer **30**. That is, the embodiment employs the transparent conductive oxide layer **30** instead of a second conductive semiconductor layer of the light emitting device according to the related art.

Therefore, photons emitted from the active layer **12** can be extracted to the outside through the transparent conductive oxide layer **30**. As a result, photons emitted from the active layer **12** may not be absorbed in the semiconductor layer, so that the light efficiency can be improved.

It has been described above that the transparent conductive oxide layer **30** is primarily formed and the active layer **12** and the first conductive semiconductor layer **13** are sequentially formed on the transparent conductive oxide layer **30**.

However, according to another embodiment, similar to the process of forming the light-emitting structure in a vertical light-emitting device of the related art, an n-type semiconductor layer, an active layer and a p-type semiconductor layer may be sequentially formed on the substrate **5**. In addition, when the substrate **5** is removed through the lift off process, the n-type semiconductor layer attached to the substrate **5** may also be separated and the transparent conductive oxide layer **30** may be formed on the active layer. In addition, the first electrode **80** may be electrically connected to the transparent conductive oxide layer **30**.

FIG. **6** is a view showing another example of a light-emitting device according to the embodiment. In the following description about the light-emitting device shown in FIG. **6**, components and structures the same as those described with reference to FIG. **1** will not be further described in order to avoid redundancy.

In the light-emitting device according to the embodiment, an ohmic reflective electrode **19** may be disposed under the light-emitting structure. The ohmic reflective electrode **19** may be configured to perform the functions of the reflective electrode **17** and the ohmic contact layer **15** described with reference to FIG. **1**. Thus, the ohmic reflective electrode **19** may make contact with the first conductive semiconductor layer **13** and have a function of reflecting light incident thereto from the light-emitting structure.

A light-emitting structure used in a light-emitting device according to the related art includes a first conductive semiconductor layer doped with first conductive dopants and a second conductive semiconductor layer doped with second conductive dopants. However, a light-emitting structure used in the light-emitting device according to the embodiment may be constituted by the first conductive semiconductor layer **13**, the active layer **12** and the transparent conductive oxide layer **30**.

The transparent conductive oxide layer **30** may include an ITO (Indium Tin Oxide) or a ZnO. For instance, the transparent conductive oxide layer **30** may include at least one selected from the group consisting of an ITO (Indium Tin Oxide), an IZO (Indium Zinc Oxide), an AZO (Aluminum Zinc Oxide), an AGZO (Aluminum Gallium Zinc Oxide), an IZTO (Indium Zinc Tin Oxide), an IAZO (Indium Aluminum Zinc Oxide), an IGZO (Indium Gallium Zinc Oxide), an IGTO (Indium Gallium Tin Oxide), an ATO (Antimony Tin Oxide), a GZO (Gallium Zinc Oxide), an IZON (IZO Nitride), and ZnO.

The active layer **12** may be disposed under the transparent conductive oxide layer **30**. The active layer **12** may make contact with a bottom surface of the transparent conductive oxide layer **30**. The first conductive semiconductor layer **13** may be disposed under the active layer **12**. The first conductive semiconductor layer **13** may make contact with a bottom surface of the active layer **12**.

The light-emitting device according to the embodiment may include the first electrode **80** electrically connected to the transparent conductive oxide layer **30**. For example, the first electrode **80** may be disposed on the transparent conductive oxide layer **30**. The first electrode **80** may make contact with the transparent conductive oxide layer **30**.

According to the embodiment, for instance, the first electrode **80** may serve as an n-type electrode and the reflective electrode **17** may serve as a p-type electrode. In this case, the first conductive semiconductor layer **13** may include a p-type semiconductor layer doped with p-type dopants as first conductive dopants. The transparent conductive oxide layer **30**, for example, may has a thickness in the range of 10 nm to 500 nm. The transparent conductive oxide layer **30** has a superior current spreading characteristic, so the transparent conductive oxide layer **30** can effectively spread current input from the first electrode **80**. The transparent conductive oxide layer **30** may spread electrons input from the first electrode **80** to effectively transfer the electrons to the active layer **12**.

According to the embodiment, a first barrier layer constituting the active layer **12** may be formed of nitride semiconductor including In or Al. In this case, the first barrier layer may make contact with a bottom surface of the transparent conductive oxide layer **30**. The first barrier layer may make ohmic-contact with the transparent conductive oxide layer **30**.

According to the embodiment, power may be applied to the light-emitting structure through the reflective electrode **17** and the first electrode **80**. According to the embodiment, the first electrode **80** may be realized in the form of a multiple layer. The first electrode **80** may include an ohmic layer, an intermediate layer, and an upper layer. The ohmic layer may include a material selected from the group consisting of Cr, V, W, Ti, and Zn to realize ohmic contact. The intermediate layer may be realized by using a material selected from the group consisting of Ni, Cu, and Al. For example, the upper layer may include Au. The first electrode **80** may include at least one selected from the group consisting of Cr, V, W, Ti, Zn, Ni, Cu, Al, and Au.

A light-emitting structure used in a light-emitting device according to the related art includes a first conductive semiconductor layer doped with first conductive dopants and a second conductive semiconductor layer doped with second conductive dopants. However, a light-emitting structure used in the light-emitting device according to the embodiment may be constituted by the first conductive semiconductor layer **13**, the active layer **12** and the transparent conductive oxide layer **30**. That is, the embodiment employs the transparent conductive oxide layer **30** instead of a second conductive semiconductor layer of the light-emitting device according to the related art.

Therefore, photons emitted from the active layer **12** can be extracted to the outside through the transparent conductive oxide layer **30**. As a result, photons emitted from the active layer **12** may not be absorbed in the semiconductor layer, so that the light efficiency can be improved.

FIG. **7** is a view showing a light-emitting device package to which the light-emitting device according to the embodiment is applied.

Referring to FIG. **7**, the light-emitting device package according to the embodiment may include a body **120**, first and second lead electrodes **131** and **132** formed on the body **120**, a light-emitting device **100** provided on the body **120** and electrically connected to the first and second lead electrodes **131** and **132** and a molding member **140** that surrounds the light-emitting device **100**.

The body **120** may include silicon, synthetic resin or metallic material, and an inclined surface may be formed in the vicinity of the light-emitting device **100**.

The first and second lead electrodes **131** and **132** are electrically isolated from each other to supply power to the light-emitting device **100**. The first and second lead electrode **131** and **132** can improve the light efficiency by reflecting the light emitted from the light-emitting device **100**. Further, the first and second lead electrodes **131** and **132** may dissipate heat generated from the light-emitting device **100** to the outside.

The light-emitting device **100** can be installed on the body **120** or the first or second lead electrode **131** or **132**.

The light-emitting device **100** may be electrically connected to the first and second lead electrodes **131** and **132** through one of a wire scheme, a flip-chip scheme, and a die-bonding scheme.

The molding member **140** may surround the light-emitting device **100** to protect the light-emitting device **100**. In addition, the molding member **140** may include phosphors to change the wavelength of the light emitted from the light-emitting device **100**.

A plurality of light-emitting device or light-emitting device packages according to the embodiment may be arrayed on a substrate, and an optical member including a lens, a light guide plate, a prism sheet, or a diffusion sheet may be provided on the optical path of the light emitted from the light-emitting device package. The light-emitting device package, the substrate, and the optical member may serve as a light unit. The light unit is realized in a top view type or a side view type and variously provided in display devices of a portable terminal and a laptop computer or a lighting apparatus and an indicator apparatus. In addition, a lighting apparatus according to another embodiment can include a light-emitting device, or a light-emitting device package according to the embodiment. For example, the lighting apparatus may include a lamp, a signal lamp, an electric sign board and a headlight of a vehicle.

The light-emitting device according to the embodiment may be applied to the light unit. The light unit has a structure in which a plurality of light-emitting devices are arrayed. The light unit may include a display device as shown in FIGS. **8** and **9** and the lighting apparatus as shown in FIGS. **10** to **14**.

Referring to FIG. **8**, a display device **1000** according to the embodiment includes a light guide plate **1041**, a light-emitting module **1031** for supplying the light to the light guide plate **1041**, a reflective member **1022** provided below the light guide plate **1041**, an optical sheet **1051** provided above the light guide plate **1041**, a display panel **1061** provided above the optical sheet **1051**, and a bottom cover **1011** for receiving the light guide plate **1041**, the light-emitting module **1031**, and the reflective member **1022**. However, the embodiment is not limited to the above structure.

The bottom cover **1011**, the reflective member **1022**, the light guide plate **1041** and the optical sheet **1051** may constitute a light unit **1050**.

The light guide plate **1041** diffuses the light to provide surface light. The light guide plate **1041** may include transparent material. For example, the light guide plate **1041** may include one of acryl-based resin, such as PMMA (polymethyl methacrylate), PET (polyethylene terephthalate), PC (polycarbonate), COC (cyclic olefin copolymer) and PEN (polyethylene naphthalate) resin.

The light-emitting module **1031** supplies the light to at least one side of the light guide plate **1041**. The light-emitting module **1031** serves as the light source of the display device.

At least one light-emitting module **1031** is provided to directly or indirectly supply the light from one side of the light guide plate **1041**. The light-emitting module **1031** may include a substrate **1033** and light-emitting devices **100** or the light-emitting device package **200** according to the embodiment described above. The light-emitting packages **200** may be arrayed on the substrate **1033** while being spaced apart from each other at the predetermined interval.

The substrate **1033** may be a printed circuit board (PCB) including a circuit pattern. In addition, the substrate **1033** may also include a metal core PCB (MCPCB) or a flexible PCB (FPCB) as well as the PCB, but the embodiment is not limited thereto. If the light-emitting device packages **200** are installed on the lateral side of the bottom cover **1011** or on a heat dissipation plate, the substrate **1033** may be omitted. The heat dissipation plate may partially make contact with the top surface of the bottom cover **1011**.

In addition, the light-emitting device packages **200** are installed such that light exit surfaces of the light-emitting device packages **200** are spaced apart from the light guide plate **1041** at a predetermined distance, but the embodiment is not limited thereto. The light-emitting device packages **200** may directly or indirectly supply the light to a light incident part, which is one side of the light guide plate **1041**, but the embodiment is not limited thereto.

The reflective member **1022** may be disposed below the light guide plate **1041**. The reflective member **1022** reflects the light, which travels downward through the bottom surface of the light guide plate **1041**, upward, thereby improving the brightness of the light unit **1050**. For example, the reflective member **1022** may include PET, PC or PVC resin, but the embodiment is not limited thereto. The reflective member **1022** may serve as the top surface of the bottom cover **1011**, but the embodiment is not limited thereto.

The bottom cover **1011** may receive the light guide plate **1041**, the light-emitting module **1031**, and the reflective member **1022** therein. To this end, the bottom cover **1011** has a receiving section **1012** having a box shape with an opened top surface, but the embodiment is not limited thereto. The bottom cover **1011** can be coupled with the top cover (not shown), but the embodiment is not limited thereto.

The bottom cover **1011** can be manufactured through a press process or an extrusion process by using metallic material or resin material. In addition, the bottom cover **1011** may include metal or non-metallic material having superior thermal conductivity, but the embodiment is not limited thereto.

The display panel **1061**, for example, is an LCD panel including first and second transparent substrates, which are opposite to each other, and a liquid crystal layer interposed between the first and second substrates. A polarizing plate can be attached to at least one surface of the display panel **1061**, but the embodiment is not limited thereto. The display panel **1061** displays information by using light passing through the optical sheet **1051**. The display device **1000** can be applied to various portable terminals, monitors of notebook computers and laptop computers, and televisions.

The optical sheet **1051** is disposed between the display panel **1061** and the light guide plate **1041** and includes at least one transmissive sheet. For example, the optical sheet **1051** includes at least one of a diffusion sheet, horizontal and vertical prism sheets, and a brightness enhanced sheet. The diffusion sheet diffuses the incident light, the horizontal and/or vertical prism sheet concentrates the incident light onto a display region, and the brightness enhanced sheet improves the brightness by reusing the light to be lost. In addition, a protective sheet can be provided on the display panel **1061**, but the embodiment is not limited thereto.

The light guide plate **1041** and the optical sheet **1051** can be provided on the optical path of the light-emitting module **1031** as optical members, but the embodiment is not limited thereto.

FIG. **9** is a view showing another example of a display device according to the embodiment.

Referring to FIG. **9**, the display device **1100** includes a bottom cover **1152**, a substrate **1020** on which the light-emitting devices **100** are arrayed, an optical member **1154**, and a display panel **1155**.

The substrate **1020** and the light-emitting device packages **200** may constitute a light-emitting module **1060**. The bottom cover **1152**, at least one light-emitting module **1060**, and the optical member **154** may constitute a light unit.

The bottom cover **1152** can be provided therein with a receiving section **1153**, but the embodiment is not limited thereto.

In this case, the optical member **1154** may include at least one of a lens, a light guide plate, a diffusion sheet, horizontal and vertical prism sheets, and a brightness enhanced sheet. The light guide plate may include PC or PMMA (Poly methyl methacrylate). The light guide plate can be omitted. The diffusion sheet diffuses the incident light, the horizontal and vertical prism sheets concentrate the incident light onto a display region, and the brightness enhanced sheet improves the brightness by reusing the light to be lost.

The optical member **1154** is disposed above the light-emitting module **1060** in order to convert the light emitted from the light-emitting module **1060** into the surface light. In addition, the optical member **1154** may diffuse or collect the light.

FIGS. **10** to **12** are views showing a lighting apparatus according to the embodiment.

FIG. **10** is a top perspective view of the lighting apparatus, FIG. **11** is a bottom perspective view of the lighting apparatus shown in FIG. **10** and FIG. **12** is an exploded perspective view of the lighting apparatus shown in FIG. **10**.

Referring to FIGS. **10** to **12**, the lighting apparatus according to the embodiment may include a cover **2100**, a light source module **2200**, a radiator **2400**, a power supply part **2600**, an inner case **2700**, and a socket **2800**. The lighting apparatus according to the embodiment may further include at least one of a member **2300** and a holder **2500**. The light source module **2200** may include the light-emitting device package according to the embodiment.

For example, the cover **2100** may have a bulb shape or a hemispheric shape. The cover **2100** may have a hollow structure which is partially open. The cover **2100** may be optically coupled with the light source module **2200**. For example, the cover **2100** may diffuse, scatter, or excite light provided from the light source module **2200**. The cover **2100** may be an optical member. The cover **2100** may be coupled with the radiator **2400**. The cover **2100** may include a coupling part which is coupled with the radiator **2400**.

The cover **2100** may include an inner surface coated with a milk-white pigment. The milk-white pigment may include a diffusion material to diffuse light. The roughness of the inner surface of the cover **2100** may be greater than the roughness of the outer surface of the cover **2100**. The surface roughness is provided for the purpose of sufficiently scattering and diffusing the light from the light source module **2200**.

The cover **2100** may include glass, plastic, polypropylene (PP), polyethylene (PE) or polycarbonate (PC). The polycarbonate (PC) has the superior light resistance, heat resistance and strength among the above materials. The cover **2100** may be transparent so that a user may view the light source module **2200** from the outside, or may be opaque. The cover **2100** may be formed through a blow molding scheme.

The light source module **220** may be disposed at one surface of the radiator **2400**. Accordingly, the heat from the light source module **220** is transferred to the radiator **2400**. The light source module **2200** may include a light source **2210**, a connection plate **2230**, and a connector **2250**.

The member **2300** is disposed on a top surface of the radiator **2400**, and includes guide grooves **2310** into which a plurality of light sources **2210** and the connector **2250** are inserted. The guide grooves **2310** correspond to a substrate of the light source **2210** and the connector **2250**.

A surface of the member **2300** may be coated with a light reflective material. For example, the surface of the member **2300** may be coated with white pigment. The member **2300** reflects again light, which is reflected by the inner surface of the cover **2100** and is returned to the direction of the light source module **2200**, to the direction of the cover **2100**. Accordingly, the light efficiency of the lighting apparatus according to the embodiment may be improved.

For example, the member **2300** may include an insulating material. The connection plate **2230** of the light source module **2200** may include an electrically conductive material. Accordingly, the radiator **2400** may be electrically connected to the connection plate **2230**. The member **2300** may be formed by an insulating material, thereby preventing the connection plate **2230** from being electrically shorted with the radiator **2400**. The radiator **2400** receives heat from the light source module **2200** and the power supply part **2600** and dissipates the heat.

The holder **2500** covers a receiving groove **2719** of an insulating part **2710** of an inner case **2700**. Accordingly, the power supply part **2600** received in the insulating part **2710** of the inner case **2700** is sealed. The holder **2500** includes a guide protrusion **2510**. The guide protrusion **2510** has a hole and a protrusion of the power supply part **2600** extends by passing through the hole.

The power supply part **2600** processes or converts an electric signal received from the outside and provides the processed or converted electric signal to the light source module **2200**. The power supply part **2600** is received in the receiving groove **2719** of the inner case **2700**, and is sealed inside the inner case **2700** by the holder **2500**.

The power supply part **2600** may include a protrusion **2610**, a guide part **2630**, a base **2650**, and an extension part **2670**.

The guide part **2630** has a shape protruding from one side of the base **2650** to the outside. The guide part **2630** may be inserted into the holder **2500**. A plurality of components may be disposed on one surface of the base **2650**. For example, the components may include a DC converter to convert AC power provided from an external power supply into DC power, a driving chip to control the driving of the light source module **2200**, and an electrostatic discharge (ESD) protection device to protect the light source module **2200**, but the embodiment is not limited thereto.

The extension part **2670** has a shape protruding from an opposite side of the base **2650** to the outside. The extension part **2670** is inserted into an inside of the connection part **2750** of the inner case **2700**, and receives an electric signal from the outside. For example, a width of the extension part **2670** may be smaller than or equal to a width of the connection part **2750** of the inner case **2700**. First terminals of a "+ electric wire" and a "– electric wire" are electrically connected to the extension part **2670** and second terminals of the "+ electric wire" and the "– electric wire" may be electrically connected to a socket **2800**.

The inner case **2700** may include a molding part therein together with the power supply part **2600**. The molding part is prepared by hardening molding liquid, and the power supply part **2600** may be fixed inside the inner case **2700** by the molding part.

FIGS. **13** and **14** are views showing another example of a lighting apparatus according to the embodiment.

FIG. **13** is a perspective view of the lighting apparatus according to the embodiment and FIG. **14** is an exploded perspective view of the lighting apparatus shown in FIG. **13**. In the following description about the lighting apparatus shown in FIGS. **13** and **14**, components and structures the same as those described with reference to FIGS. **10** to **12** will not be further described in order to avoid redundancy.

Referring to FIGS. **13** and **14**, the lighting apparatus according to the embodiment may include a cover **3100**, a light source part **3200**, a radiator **3300**, a circuit part **3400**, an inner case **3500**, and a socket **3600**. The light source part **3200** may include the light-emitting device or the light-emitting device module according to the embodiment.

The cover **3100** may have a hollow bulb shape. The cover **3100** has an opening **3110**. The light source part **3200** and a member **3350** may be inserted through the opening **3110**.

The cover **3100** may be coupled with the radiator **3300** and may surround the light source part **3200** and the member **3350**. The light source part **3200** and the member **3350** may be blocked from the outside by the coupling between the cover **3100** and the radiator **3300**. The cover **3100** may be coupled with the radiator **3300** by an adhesive or various schemes such as a rotation coupling scheme and a hook coupling scheme. The rotation coupling scheme is a scheme where a thread of the cover **3100** is coupled with a screw groove of the radiator **3300**, and the cover **3100** is coupled with the radiator **3300** by rotation of the cover **3100**. The hook coupling scheme is a scheme where a projection of the cover **3100** is inserted into a groove of the radiator **3300** so that the cover **3100** is coupled with the radiator **3300**.

The light source part **3200** is disposed at the member **3350** of the radiator **3300**, and a plurality of light source parts **3200** may be provided. In detail, the light source part **3200** may be disposed on at least one of side surfaces of the member **3350**. In addition, the light source part **3200** may be disposed at an upper portion of the side surface of the member **3350**.

Referring to FIG. **14**, the light source part **3200** may be disposed at three of six side surfaces of the member **3350**. However, the embodiment is not limited thereto, and the light source part **3200** may be disposed at all side surfaces of the member **3350**. The light source part **3200** may include a substrate **3210** and a light-emitting device **3230**. The light-emitting device **3230** may be disposed on one surface of the substrate **3210**.

The substrate **3210** has a rectangular plate shape, but the embodiment is not limited thereto. The substrate **3210** may have various shapes. For example, the substrate **3210** may have a circular plate shape or a polygonal plate shape. The substrate **3210** may be provided by printing a circuit pattern on an insulator. For example, the substrate **3210** may include a typical printed circuit board (PCB), a metal core PCB, a flexible PCB, and a ceramic PCB. In addition, the substrate may have a COB (chips on board) type in which LED chips, which are not packaged, are directly bonded on the PCB. In addition, the substrate **3210** may include a material suitable to reflect light, or the surface of the substrate may have a color such as a white color or a silver color to effectively reflect the light. The substrate **3210** may be electrically connected to the circuit part **3400** received in the radiator **3300**. For example, the substrate **3210** and the circuit part **3400** may be connected to each other by a wire. The wire may connect the substrate **3210** and the circuit part **3400** to each other by passing through the radiator **3300**.

The light-emitting device **3230** may include a luminescence material. The luminescence material may include at least one of garnet-based phosphors (YAG, or TAG), silicate-based phosphors, nitride-based phosphors, and oxynitride-based phosphors. The luminescence material may include at least one of a red luminescence material, a yellow luminescence material and a green luminescence material.

The radiator **3300** is coupled with the cover **3100**, and may radiate heat from the light source part **3200**. The radiator **330** has a predetermined volume, and includes a top surface **3310** and a side surface **3330**. The member **3350** may be disposed on the top surface **3310** of the radiator **3310**. The top surface **3310** of the radiator **3300** may be coupled with the cover **3100**. The top surface **3310** of the radiator **3300** may have a shape corresponding to an opening **3110** of the cover **3100**.

A plurality of heat radiation pins **3370** may be disposed at the side surface **3330** of the radiator **3300**. The heat radiation pin **3370** may extend outward from the side surface **3330** of the radiator **3300** or may be connected to the side surface **3330** of the radiator **3300**. The heat radiation pin **3370** may improve heat radiation efficiency by increasing a heat radiation area of the radiator **3300**. The side surface **3330** may not include the heat radiation pin **3370**.

The member **3350** may be disposed on the top surface of the radiator **3300**. The member **3350** may be integrated with or coupled to the top surface **3310** of the radiator **3300**. The member **3350** may have the shape of a polygonal prism. In detail, the member **3350** may have the shape of a hexahedral prism. The member **3350** having the shape of a hexahedral prism includes a top surface, a bottom surface, and six side surfaces. The member **3350** may have the shape of a circular prism or the shape of an elliptical prism as well as the shape of a hexahedral prism. When the member **3350** has the shape of a circular prism or the shape of an elliptical prism, the substrate **3210** of the light source part **3200** may be a flexible substrate.

The light source part **3200** may be disposed at six side surfaces of the member **3350**. The light source part **3200** may be disposed at all or some of the six side surfaces of the member **3350**. The light source part **3200** is disposed at three of the six side surfaces of the member **3350**.

The substrate **3210** is disposed at the side surface of the member **3350**. The side surface of the member **3350** may be substantially vertical to the top surface **3310** of the radiator **3300**. Accordingly, the substrate **3210** and the top surface of the radiator **3300** may be substantially vertical to each other.

The member **3350** may include a material representing thermal conductivity. Thus, heat from the light source part **3200** can be rapidly transferred to the member **3350**. For example, the material for the member **3350** may include an alloy of metals such as aluminum (Al), nickel (Ni), copper (Cu), magnesium (Mg), silver (Ag), or tin (Sn). In addition, the member **3350** may include a plastic material having thermal conductivity. The plastic material having thermal conductivity is advantageous in that it is lighter than the metal and has thermal conductivity in a single direction.

The circuit part **3400** receives power from the outside, and converts the received power suitably for the light source part **3200**. The circuit part **3400** provides the converted power to the light source part **3200**. The circuit part **3400** may be disposed at the radiator **3300**. In detail, the circuit part **3400** may be received in the inner case **3500**, and may be received in the radiator **3300** together with the inner case **3500**. The circuit part **3400** may include a circuit board **3410** and a plurality of components mounted on the circuit board **3410**.

The circuit board **3410** has a circular shape, but the embodiment is not limited thereto. That is, the circuit board **3410** may have various shapes. For example, the circuit board may have an elliptical shape or a polygonal shape. The circuit board **3410** may be provided by printing a circuit pattern on an insulator.

The circuit board **3410** is electrically connected to the substrate **3210** of the light source part **3200**. For example, the circuit part **3410** and the substrate **3210** may be connected to each other by a wire. The wire may be disposed inside the radiator **3300** to connect the substrate **3210** to the circuit board **3410**. For example, a plurality of components **3430** may include a direct current converter converting AC power provided from an external power supply into DC power, a driving chip controlling driving of the light source part **3200**, and an electrostatic discharge (ESD) protective device.

The inner case **3500** receives the circuit part **3400** therein. The inner case **3500** may include a receiving part **3510** to receive the circuit part **3400**. For example, the receiving part **3510** may have a cylindrical shape. The shape of the receiving part **3510** may be changed according to the shape of the radiator **3300**. The inner case **3500** may be received in the radiator **3300**. The receiving part **3510** of the inner case **3500** may be received in a receiving part which is formed at a bottom surface of the radiator **3300**.

The inner case **3500** may be coupled with the socket **3600**. The inner case **3500** may include a connecting part **3530** coupled with the socket **3600**. The connecting part **3530** may have a thread structure corresponding to a screw groove structure of the socket **3600**. The inner case **3500** is an insulator. Accordingly, the inner case **3500** prevents electric short between the circuit part **3400** and the radiator **3300**. For example, the inner case **3500** may include a plastic or resin material.

The socket **3600** may be coupled with the inner case **3500**. In detail, the socket **3600** may be coupled with the connecting part **3530** of the inner case **3500**. The socket **3600** may have the structure the same as that of a conventional incandescent light bulb. The socket **3600** is electrically connected to the circuit part **3400**. For example, the circuit part **3400** and the socket **3600** may be connected to each other by a wire. If external power is applied to the socket **3600**, the external power may be transferred to the circuit part **3400**. The socket **3600** may have a screw groove structure corresponding to a thread structure of the connecting part **3550**.

Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to affect such feature, structure, or characteristic in connection with other ones of the embodiments.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

The invention claimed is:

1. A light-emitting device comprising:

a transparent conductive oxide layer;

an active layer making direct contact with a bottom surface of the transparent conductive oxide layer;

a first conductive semiconductor layer making contact with a bottom surface of the active layer;

a reflective electrode electrically connected to the first conductive semiconductor layer; and

a first electrode electrically connected to the transparent conductive oxide layer, wherein a first barrier layer that constitutes the active layer includes a nitride semiconductor including In or Al, and wherein the first barrier layer makes direct contact with the bottom surface of the transparent conductive oxide layer.

2. The light-emitting device of claim **1**, wherein the transparent conductive oxide layer includes at least one of ITO and ZnO.

3. The light-emitting device of claim **1**, wherein the transparent conductive oxide layer has a thickness in a range of 10 nm to 500 nm.

4. The light-emitting device of claim **1**, wherein the reflective electrode is provided under the first conductive semiconductor layer.

5. The light-emitting device of claim **1**, further including a metal layer provided under the first conductive semiconductor layer and around the reflective electrode.

6. The light-emitting device of claim **5**, wherein the metal layer makes contact with a bottom surface of the first conductive semiconductor layer.

7. The light-emitting device of claim **5**, wherein the metal layer has a first region making contact with a bottom surface of the first conductive semiconductor layer and a second region extending outward from the first region.

8. The light-emitting device of claim **5**, further including a bonding layer and a support member under the metal layer.

9. The light-emitting device of claim **1**, further including an ohmic contact layer between the first conductive semiconductor layer and the reflective electrode.

10. The light-emitting device of claim **9**, wherein a lateral width of the ohmic contact layer is less than that of the active layer.

11. The light-emitting device of claim **9**, wherein a lateral width of the ohmic contact layer is greater than that of the reflective electrode.

12. A light-emitting device package comprising:

a body;

the light-emitting device according to claim **1** on the body; and

first and second lead electrodes electrically connected to the light-emitting device.

13. A light unit comprising:

a substrate;

the light-emitting device according to claim **1** on the substrate; and an optical member serving as an optical path for light emitted from the light-emitting device.

14. The light-emitting device of claim **1**, wherein a lateral width of the reflective electrode is less than that of the active layer.

15. The light-emitting device of claim **1**, wherein the active layer includes only at least one quantum well and at least one quantum barrier layer.

16. A light-emitting device comprising:

a transparent conductive oxide layer;

an active layer making direct contact with a bottom surface of the transparent conductive oxide layer;

a first conductive semiconductor layer making contact with a bottom surface of the active layer;

an ohmic reflective electrode electrically connected to the first conductive semiconductor layer; and

a first electrode electrically connected to the transparent conductive oxide layer, wherein a first barrier layer that constitutes the active layer includes a nitride semiconductor including In or Al, and wherein the first barrier layer makes direct contact with the bottom surface of the transparent conductive oxide layer.

17. The light-emitting device of claim **16**, wherein the reflective electrode is provided under the first conductive semiconductor layer.

18. The light-emitting device of claim **16**, wherein a lateral width of the reflective electrode is less than that of the active layer.

19. The light-emitting device of claim **16**, wherein the active layer includes only at least one quantum well and at least one quantum barrier layer.

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